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ABSTRACT

The United States Training and Employment Service General Aptitude Test Battery (GATB), first published in 1947, has been included in a continuing program of research to validate the tests against success in many different occupations. The GATB consists of 12 tests which measure nine aptitudes: General Learning Ability; Verbal Aptitude; Numerical Aptitude; Spatial Aptitude; Form Perception; Clerical Perception; Motor Coordination; Finger Dexterity; and Manual Dexterity. The aptitude scores are standard scores with 100 as the average for the general working population, and a standard deviation of 20. Occupational norms are established in terms of minimum qualifying scores for each of the significant aptitude measures which, when combined, predict job performance. Cutting scores are set only for those aptitudes which aid in predicting the performance of the job duties of the experimental sample. The GATB norms described are appropriate only for jobs with content similar to that shown in the job description presented in this report. A description of the validation sample is included. (AG)

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TECHNICAL REPORT

ON

STANDARDIZATION OF THE GENERAL APTITUDE TEST BATTERY

FOR

LIGHT-BULB ASSEMBLER 7-00.070

B-297 or S-56

U. S. Employment Service in
Cooperation with
California State Employment Service

U. S. DEPARTMENT OF LABOR
Bureau of Employment Security
Washington 25, D. C.
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STANDARDIZATION OF THE GENERAL APTITUDE TEST BATTERY FOR LIGHT-BULB ASSEMBLER 7-00.070

B-297 or S-56

Summary

The General Aptitude Test Battery, B-1002A, was administered to a sample of 50 women employed as Light-Bulb Assemblers by the General Electric Company, Oakland Lamp Works, Oakland, California. Supervisors' rank order ratings were used as the criterion. The following aptitudes, selected on the basis of mean scores, job analysis data and correlations with the criterion were found to be significant for this occupation: Motor Coordination (K), Finger Dexterity (F), and Manual Dexterity (M).

GATB Norms for Light-Bulb Assembler 7-00.070 - B-297 or S-56

Table I shows, for B-1001 and B-1002, the minimum acceptable scores for each aptitude included in the test norms for Light-Bulb Assembler 7-00.070.

TABLE I

Minimum Acceptable Scores on B-1001 and B-1002 for B-297 or S-56

B-1001			B-1002		
Aptitude	Tests	Minimum Acceptable Aptitude Score	Aptitude	Tests	Minimum Acceptable Aptitude Score
T	CB-1-G CB-1-K	85	K	Part 8	90
F	CB-1-O CB-1-P	100	F	Part 11 Part 12	95
M	CB-1-M CB-1-N	95	M	Part 9 Part 10	90

Effectiveness of Norms

The data in Table IV indicate that 10 of the 18 poor workers, or 56% of them, did not achieve the minimum scores established as cutting scores on the recommended test norms. This shows that 56% of the poor workers would not have been hired if the recommended test norms had been used in the selection process. Moreover, 24 of the 32 workers who made qualifying test scores, or 75%, were good workers.

TECHNICAL REPORT

I. Problem

This study was conducted to determine the best combination of aptitudes and minimum scores to be used as norms on the General Aptitude Test Battery for the occupation of Light-Bulb Assembler 7-00.070.

II. Sample

The GATB, B-1002A, was administered to 81 women employed as Light-Bulb Assemblers on the day and evening shifts at the General Electric Company, Oakland Lamp Works, Oakland, California. The testing took place during the period of September 28, 1953 through October 5, 1953. Plant management informed the workers of the purpose of the project. Everyone who volunteered was allowed to take the tests, provided she had reached the minimum standard of production. (Workers who had not reached the minimum standard of production were still in the trainee stage.) Later, scores and ratings of 6 workers were excluded because these workers were unable to perform on one or more of the tests. This reduced the sample to 75. When correlation coefficients were obtained for this sample, it was found that age (r = .242) and experience (r = .330) were significantly related to the supervisors' ratings. Education showed a low negative correlation (r = -.205) with the criterion. To minimize the effects of these factors, the range for education was restricted to 6 through 12 years, and for experience to 10 through 100 months. This resulted in satisfactory reductions of the relationships obtained between these variables and the criterion, and also reduced the final sample to 50 workers. All workers employed on this job were women, who with one exception, were right-handed. Position of the operators in relation to the machines requires right-handedness.

The possibility of a difference in performance between day and evening shift workers was checked by obtaining the average hourly incentive paid to day shift incentive workers and to evening shift incentive workers over a period of three weeks:

	Day	Evening
1st week	$1.723	$1.733
2nd week	1.732	1.726
3rd week	1.723	1.736

According to the plant management the differences shown are negligible in terms of production or performance. Therefore, both shifts were combined into one sample.

At this plant of the General Electric Company, the job of Light-Bulb Assembler is an operation which is performed by a unit of four workers: Sealer, Baser, Finisher, and Stem Operater. Most of the workers in this sample have experience at one or more of these operations, since it is the policy of the plant to maximize the interchangeability of workers performing these operations. The company distinguishes between training time and length of time for workers to reach incentive (minimum standard) production (9600 lamps per day per each unit of Sealer, Baser, and Finisher).

	Standard Training Time	Average to Reach Incentive	
Stem Maker	80 hours (2 weeks)	--------	
Sealer	120 hours (3 weeks)	(Mean, 10 workers)	192 hours
Baser	80 hours (2 weeks)	(Mean, 9 workers)	134 hours
Finisher	120 hours (3 weeks)	(Mean, 8 workers)	124 hours

Workers usually learn how to do the job in the standard training time, but do not have the skill to reach the incentive production rate without additional practice. The Stem Operators receive a flat hourly rate because the Stem Machine produces a surplus.

Applicants may be hired from any source, usually at the gate or through the Employment Service. There is a routine medical examination before hiring. Applicants who have a 10th grade education are preferred, although many exceptions have been made. Applicants must be right-handed. Age limits are flexible, although workers are preferred to be between 18 and 35 years. Applicants are interviewed by the nurse (who doubles as employment interviewer) and by the foreman in charge of the shift to which they are to be assigned. Job specifications, prepared by the local employment office staff, are available for reference in the plant and the company carefully adheres to the requirements in the specifications. Prospective employees are shown that section of operations where they will work and if time permits are given a plant tour.

Table II shows the means, standard deviations, ranges, Pearson product-moment correlations with the criterion and the standard errors of correlation for age, education and experience.

TABLE II

Means (M), Standard Deviations (σ), Ranges, Pearson Product-Moment Correlations with the Criterion (r) and the Standard Errors of Correlation (σ_r) for Age, Education and Experience

Light-Bulb Assembler 7-00.070

N = 50

	M	σ	Range	r	σ_r
Age (years)	29.9	5.9	20-43	.059	.141
Education (years)	10.7	1.6	6-12	.070	.141
Experience (months)	40.3	26.3	10-97	-.047	.141

There are no significant correlations between age, education or experience and the criterion. The sample does not appear to be homogeneous with respect to any of these variables, even though the ranges for experience and education were intentionally restricted in selecting the final sample.

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III. Job Description

Job Title: Light-Bulb Assembler 7-00.070

Job Summary: Performs any one or combination of the following series of duties in the assembly of electric light bulbs: makes mounts by feeding stem machine with component parts; moves mounts to machine which seals them in bulbs; attaches bases to bulbs in preparation for cementing and soldering; inspects finished lamps visually, and packs them in cartons for shipment.

Work Performed

Makes mounts: Places tiny filament coils into grooves of a small conveyor which carries them into Stem Machine for combining with lead wires and glass center tube and flange to form the mount. Removes completed mounts from racks of auxiliary conveyor bearing surplus from Stem Machine, and places mounts in racks of tray for transportation to Sealer. Observes mounts on racks for defects and assists Maintenance Mechanic in locating machine unit causing defect. Keeps records of damaged mounts. Periodically fills hoppers of Stem Machine with flanges, center tubes and pre-cut lead wires. Replaces empty support-wire spools with full ones. Fills feeder-well on machine with getter fluid when fluid level is low. When signal light indicates machine stoppage, looks over conveyor and racks for jammed or defective mount parts, removes them with tweezers, and restarts machine.

Seals mounts in bulbs: Transfers mounts rapidly and carefully from moving conveyor racks, and glass bulbs from cartons to racks on moving turntables of Sealex Machine, which inserts and fuses mounts in bulbs to form electric lamps. Observes each mount and bulb for freedom from defects, such as improper mount fusing or cracked glass. Drops defective mounts or bulbs into carton for disposal.

Attaches bases to necks of bulbs: Rapidly straightens heavy lead-wire, bends light lead-wire back over neck of bulb with fingers, and places base over neck and lead-wire, as the bulb moves past workplace in the rack of the basing wheel. Visually inspects bulbs for imperfections and removes and drops defective bulbs into carton for disposal. Observes shape of filament glow through tinted glass screen, as lamp is automatically lighted on the moving basing wheel, to make certain that filament has not been bumped or jarred.

Inspects and packs light bulbs: Removes lamp from basing wheel and examines it to insure that proper wattage and voltage stamp shows and that glass is free from dirt and cracks. Observes base of lamp for excess solder and removes excess with knife. Packs each lamp by placing it into corrugated paper case and then into a carton. Places defective lamps into chute to salvage bin. Inserts slip in each carton showing number and type of lamp.

IV. Experimental Battery

All of the tests of the GATB, B-1002A, were administered to the sample group.

V. Criterion

Production records could not be used as a criterion because they were not available for all operators. Therefore, supervisors' ratings were used as the criterion. Quality and quantity were the factors considered in the rating. Addressograph cards were prepared for each employee who had reached minimum standard production. This excluded trainees. All of the workers on this operation who met the minimum production standard were rated since it was not then known who the volunteers would be.

The actual rating process was as follows: each shift supervisor selected the highest and lowest third with respect to job performance in his group. (The remainder was the middle third.) Workers were then ranked within each third. After the names were listed in rank order, the cards were shuffled and turned over to the general supervisor, who had been supervisor of each shift before assuming his present duties and thus was familiar with the performance of each worker. By the same process he listed the workers of each shift in rank order. He then compared his list with the other. Differences were resolved by discussion with the shift supervisor. The three supervisors then jointly combined the rankings of both shifts, resolving differences by discussion.

The employees were rerated two weeks later, using the same procedure. There was so slight a variation between the two sets of ratings that it was decided to use the first set for test validation purposes. For statistical analysis, the rank order ratings were converted to linear scores.

VI. Statistical and Qualitative Analysis

Table III shows the means, standard deviations, Pearson product-moment correlations with the criterion and standard errors of correlation for the aptitudes of the GATB.

The means and standard deviations of the aptitudes are comparable to general population norms with a mean of 100 and a standard deviation of 20.

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TABLE III

Means (M), Standard Deviations (σ), Pearson Product-Moment Correlations with the Criterion (r) and Standard Errors of Correlation (σ_r) for the Aptitudes of the GATB

Light-Bulb Assembler 7-00.070

N = 50

Aptitudes	M	σ	r	σ_r
G-Intelligence	90.1	13.6	.103	.140
V-Verbal Aptitude	92.2	13.4	.084	.140
N-Numerical Aptitude	84.2	15.1	.181	.137
S-Spatial Aptitude	93.7	17.0	-.041	.141
P-Form Perception	98.0	19.0	.007	.141
Q-Clerical Perception	99.7	11.9	.125	.139
K-Motor Coordination	105.1	15.7	-.003	.141
F-Finger Dexterity	111.2	16.2	.226	.134
M-Manual Dexterity	110.3	18.1	.355*	.124

*Significant at the .05 level.

The statistical results were interpreted in the light of job analysis data. The job analysis indicated that the following aptitudes measured by the General Aptitude Test Battery appeared to be important for this occupation:

Form Perception (P) - required to visually inspect bulbs and component parts for imperfections and to observe the shape of filament glow as lamp is lighted on the basing wheel.

Motor Coordination (K) - required to move and assemble small parts rapidly as they pass by on conveyors.

Finger Dexterity (F) - required to handle tiny coils, transfer fragile mounts to racks on moving turntables and straighten or bend wires.

Manual Dexterity (M) - required to remove completed mounts, straighten heavy lead wires and pack cases into cartons.

The highest mean scores, in order of magnitude, were obtained for Aptitudes F, M, and K, respectively. All of the aptitudes have standard deviations of less than 20.

When N = 50, correlations of .361 and .279 are significant at the .01 level and .05 level, respectively. Aptitude M correlates significantly with the criterion at the .05 level of confidence.

Although Aptitudes K and F do not show significant correlations with the criterion, they have relatively high mean scores and their importance is indicated by the job analysis data. Therefore, Aptitudes K and F were included in the test norms. Aptitude M was included in the test norms on the basis of its high mean score, significant correlation with the criterion and importance as indicated by the job analysis data.

The job analysis indicated some evidence to support the inclusion of Aptitude P in the test norms. However, there was little statistical evidence to support the inclusion of Aptitude P. Therefore, it was omitted from the norms.

The minimum scores for Aptitudes K, F, and M were set at one standard deviation below the mean and rounded to the nearest five point score level. Setting cutting scores at these levels yielded the best selective efficiency for the norms and resulted in critical scores of 90, 95 and 90 for Aptitudes K, F, and M, respectively.

For the purpose of computing the tetrachoric correlation coefficient and Chi Square, the criterion was dichotomized so that approximately one-third of the sample was placed in the low criterion group. The 32 workers who received linear scores of 43 and above were placed in the high criterion group. The 18 workers who received linear scores of 42 and below were placed in the low criterion group. Table IV shows the relationship between test norms consisting of Aptitudes K, F, and M with critical scores of 90, 95 and 90, respectively and the dichotomized criterion for Light-Bulb Assembler 7-00.070. Workers in the high criterion group have been designated as "good workers" and those in the low criterion group as "poor workers."

TABLE IV

Relationship between Test Norms Consisting of Aptitudes K, F, and M with Critical Scores of 90, 95, and 90, Respectively and the Criterion for Light-Bulb Assembler 7-00.070

N = 50

	Non-Qualifying Test Scores	Qualifying Test Scores	Total
Good Workers	8	24	32
Poor Workers	10	8	18
Total	18	32	50

$r_{tet} = .48 \qquad X^2 = 3.436$

$\sigma_{r_{tet}} = .23 \qquad P/2 < .05$

The data in the above table indicate a significant relationship between the norms and the criterion for this sample.

VII. Conclusions

On the basis of job analysis data, mean scores, correlations with the criterion and their combined predictive efficiency, Aptitudes K, F and M with minimum scores of 90, 95, and 90, respectively, are recommended as norms on the GATB, B-1002, for the occupation of Light-Bulb Assembler 7-00.070. The equivalent norms for the B-1001 edition of the GATB consist of T-85, F-100 and M-95.